Phosphorus, agriculture & organic waste: a Danish P balance

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Phosphorus, agriculture & organic waste: a Danish P balance

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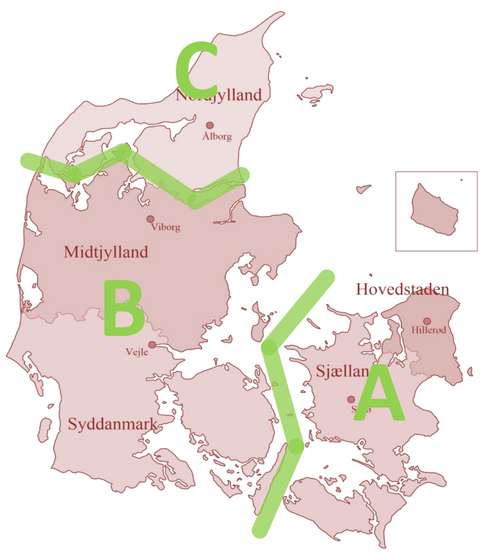
Aim

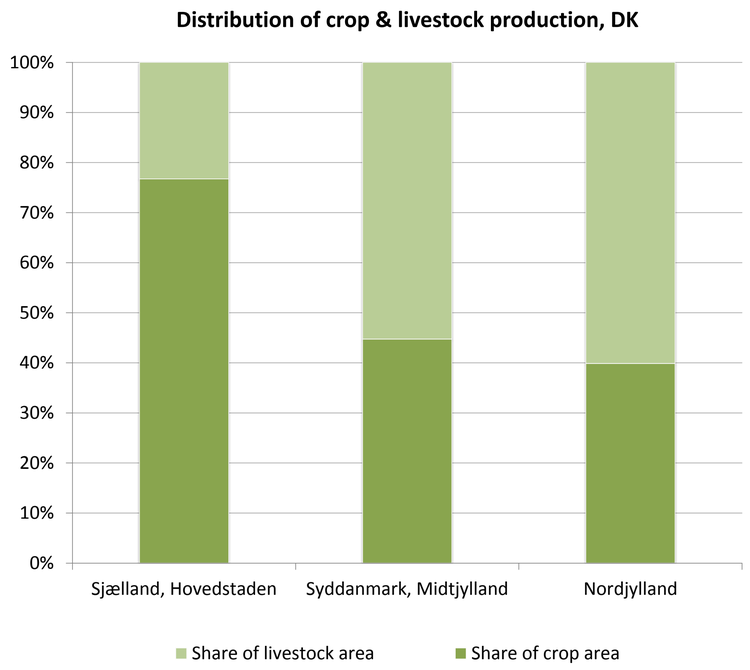
Part of the IRMAR project (Integrated Resource Management and Recovery; DTU, TU Vienna, ETH Zürich) is to map the flows of critical resources in Denmark.
One such resource is phosphorus, the supply, pathways, stocks, and losses of which have been examined on a national or supra-national level in various recent studies.
With approx. 90% of an economy's P turnover, agriculture is the focus of our study. In addition, waste streams are often discussed as still holding significant potential for nutrient recovery.

Within an economy, the applied amounts of phosphorus in agriculture may vary significantly; national-scale material flow models do not adequately capture these differences.
Using additional data on phosphorus concentrations in soils and regional data on agricultural practices (e.g. crops, animal husbandry) and waste management, we introduce regional differentiation in the Danish P household.

Methodology

By looking at sub-national regions, a more meaningful picture of the system of phosphorus stocks and flows can be provided.
We draw on statistical data from trade and waste management to establish a model of flows and stocks for Denmark; 3 regional subsystems for the processes "agriculture" and "waste management" based on pronounced differences in agricultural practice are established.
Two regions with significantly different soils and agricultural production (clay soils/crops in Zealand [A], sandy soils/animals in Northern Jutland[C]) are of particular interest; a third region (Fyn, Mid- and Southern Jutland [B]) combines these characteristics within the region, presenting a more mixed picture.
To model the flows, the STAN 2.5 software for Material Flow Analysis (MFA) is used. Processes examined are industry & trade, households, waste water treatment, waste management, and agriculture; the latter 3 on a regional scale. Our aim is to map the generation and flows of organic waste and sewage sludge in these 3 regions are and present them as an integrated part of a country-scale substance flow analysis.
Our focus is on regional differences in the phosphorus household due to differing extent of use in agriculture: different transfer coefficients and P stock dynamics in agriculture-related processes in a substance flow analysis (SFA) system.

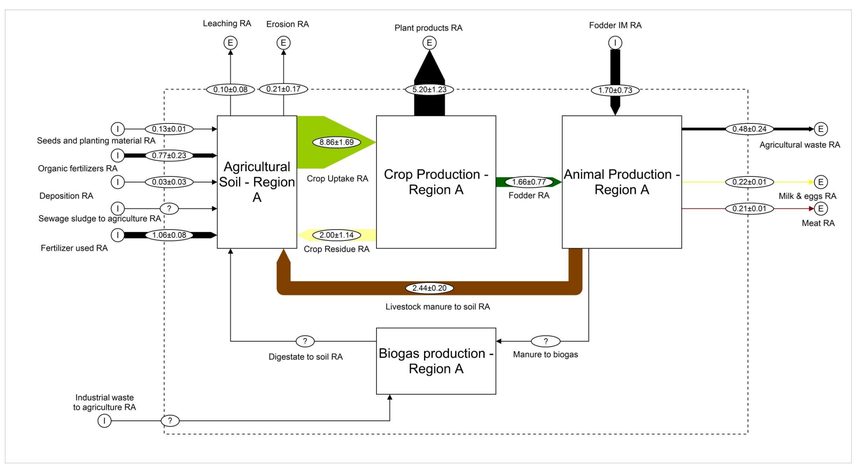




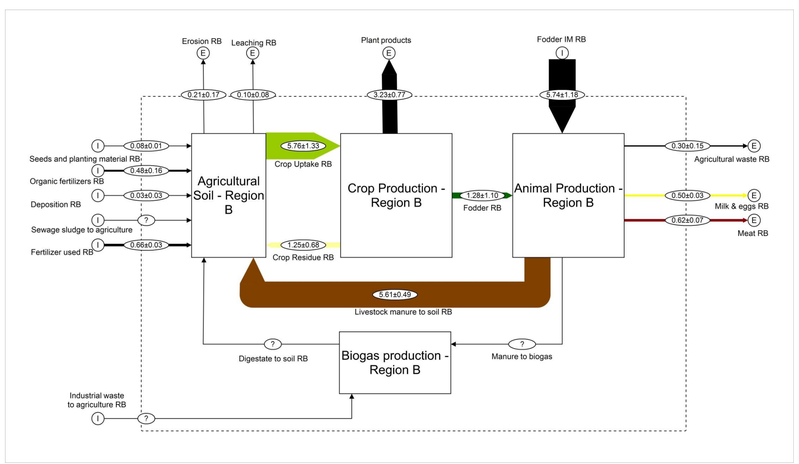
Results

A farm/region-specific quantitative phosphorus household was obtained ; it is to be linked to regional waste management processes to generate an integrated picture of phosphorus flows and stocks in Denmark.
Below t he preliminary MFA models for the process "Agriculture", showing the regional differences between the regions examined.

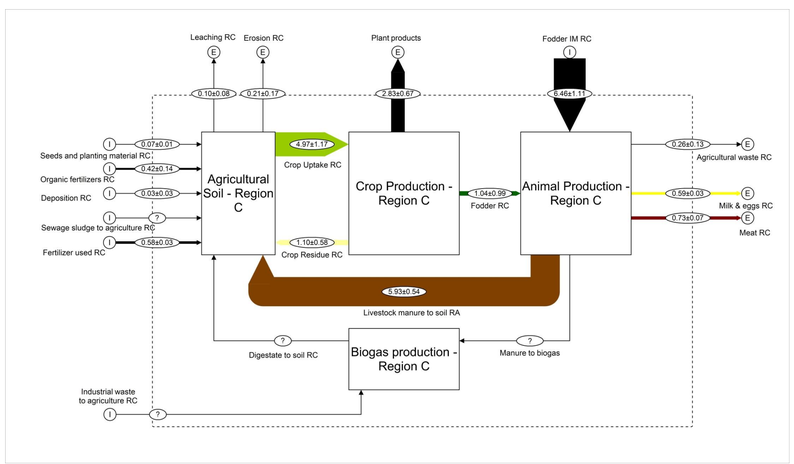
Uncertainties exist mostly in the amount of agricultural waste not remaining in the the agricultural system, or transport between regions.
Localized data on the sale of industrial waste to agricultural producers, and the amount of manure for use as substrate in anaerobic digesters, are not included yet. We expect this to hold significant potential for recovery of phosphorus.



Sjælland, Hovedstaden: kg P/ha, 2011



Syddanmark, Midtjylland: kg P/ha, 2011



Nordjylland: kg P/ha, 2011

Conclusions

This is an ongoing project; definitive conclusions are difficult to reach at this point.
The preliminary results point out, however, the imbalance of manure production from animal husbandry, concentrated in region C, and crop production, concentrated in region A. Field P balances indicate a balance of about 25kg P/ha for region A, with a negative balance in region C.

At present, manure is barely transported within the country; focus of further work will be to evaluate the potential for making surplus manure and agricultural waste available across regions to optimize the system of flows on the national scale with a view to maximizing re-use of agricultural waste materials.

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